

What is claimed is:

1. A method of patterning a surface of a substrate comprising the steps of:
 - providing the substrate;
 - 5 covering at least a portion of the surface with an electrolyte;
 - disposing at least one nanoscale electrode in the electrolyte adjacent the surface;
 - and
 - applying a current between the electrode and the substrate to electrolytically deposit material on or remove material from the substrate surface.
- 10
2. The method of claim 1 wherein the covering comprises immersing the substrate in an electrolyte bath.
- 15
3. The method of claim 1 wherein the covering comprises applying a coating layer of electrolyte to the surface.
- 20
4. The method of claim 1 further comprising the step of moving the electrode to write a pattern.
5. The method of claim 1 wherein the nanoscale electrode comprises a nanowire or nanotube.
6. The method of claim 1 wherein at least one nanoscale electrode

comprises a plurality of nanowires or nanotubes disposed in a pattern or in a spaced-apart array.

7. The method of claim 1 wherein the substrate comprises electrically
5 conductive or semiconductive material.

8. The method of claim 1 wherein the at least one nanoscale electrode
comprises at least one nanowire or nanotube partially embedded in insulating material.

10 9. The method of claim 1 wherein the at least one nanoscale electrode
comprises a plurality of spaced apart nanowires or nanotubes partially embedded in
insulating material.

10. Apparatus for patterning a surface of a substrate comprising:
15 a support for the substrate, the substrate surface in contact with an electrolyte;
 one or more nanoscale electrodes;
 a movable support for the one or more electrodes, the electrodes attached to the
movable support, and the movable support movable to dispose the one or more
electrodes in the electrolyte adjacent the surface of the substrate;
20 a power supply for supplying electrical current; and
 a conducting path connecting the substrate and the one or more electrodes to the
power supply for supplying current to electrolytically add or remove material on the
surface.

11. The apparatus of claim 10 wherein the movable support is movable parallel to the surface.

12. The apparatus of claim 10 wherein the movable support is movable
5 perpendicular to the surface.

13. The apparatus of claim 10 wherein the one or more electrodes comprise one or more nanowires or nanotubes.

10 14. The apparatus of claim 10 wherein the one or more electrodes comprise a plurality of nanowires or nanotubes.

15 15. The apparatus of claim 10 wherein the one or more electrodes comprise a plurality of nanowires or nanotubes disposed in a spaced apart array.

15

16. The apparatus of claim 10 wherein the one or more electrodes comprises one or more nanowires or nanotubes partially embedded in insulating material.

20 17. The apparatus of claim 10 wherein the one or more electrodes comprise a plurality of nanowires or nanotubes disposed in a spaced-apart array and partially embedded in insulating material.

18. The apparatus of claim 10 wherein the one or more electrodes comprise a plurality of nanoscale electrodes disposed in a spaced-apart array, and the conducting

path connecting the electrodes to the power supply is switchable to permit the connection or disconnection of selected electrodes.

19. The apparatus of claim 10 wherein the support for the one or more
5 nanoscale electrodes supports the one or more electrodes in a horizontal orientation.

20. A method of fabricating an array or pattern spaced-apart nanoscale islands of material on a surface of a surface of a substrate comprising the steps of:

- providing the substrate;
- 10 covering at least a portion the surface with an electrolyte;
- disposing in the electrolyte adjacent the surface a plurality of nanoscale electrodes configured in a spaced-apart array or pattern; and
- applying current between the electrodes and the substrate to electrolytically deposit the spaced-apart nanoscale islands of material on the surface.

15

21. A method of fabricating an array or pattern of spaced-apart nanowires or nanotubes on a surface of a substrate comprising the steps of:

- providing the substrate;
- covering at least a portion of the surface with an electrolyte for depositing a
20 material that is a catalyst for the growth of the nanowires or nanotubes;
- disposing in the electrolyte adjacent the surface a plurality of nanoscale electrodes;
- applying current between the electrodes and the substrate to electrolytically deposit regions of the catalyst material on the surface in the spaced-apart array or

pattern; and

growing the nanotubes or nanowires on the regions of catalyst material.

22. A method of fabricating a straight or curved line on a surface of a substrate
5 comprising the steps of:

providing the substrate;

covering at least a portion of the surface with an electrolyte;

disposing at least one nanoscale electrode in the electrolyte adjacent the surface;
and

10 moving the electrode parallel the surface while applying current between the
electrode and the substrate to electrolytically deposit or remove the straight curved line
on the substrate surface.

23. An article comprising:

15 a substrate having a surface; and

disposed on the surface an array or pattern of electrolytically deposited nano
islands having effective diameters less than about 500 nanometers.

24. An article comprising:

20 a substrate having a surface; and

disposed on the surface an array or pattern of electrolytically deposited
nanoscale features comprising straight or curved nanolines having widths less than 500
nanometers.

25. An article comprising:

a substrate having a surface; and

disposed on the surface a pattern or array of spaced-apart nanotubes or
5 nanowires grown on a corresponding pattern or array of electrolytically deposited nano
islands of catalyst material.

26. An article according to claim 25 comprising a magnetic recording medium
including an array of spaced-apart magnetic recording elements partially embedded in
10 nonmagnetic material, wherein the spaced-apart nanotubes or nanowires comprise the
magnetic recording elements.

27. An article according to claim 25 comprising a vacuum tube composed of a
cathode, a grid, an anode, and a collector, wherein the spaced-apart array of nanotubes
15 or nanowires comprises the cathode.

28. An article according to claim 25 comprising a field emission display
including a cathode, a spaced-apart array of electron emitters connected to the
substrate, an anode and a phosphor layer, wherein the spaced-apart array of nanotubes
20 or nanowires comprise the electron emitters.

29. An article according to claim 25 comprising a plasma display including a
plurality of plasma display cells having spaced-apart electrode pairs sealed with
ionizable gas, wherein the spaced-apart array of nanotubes or nanowires comprise the
25 spaced-apart electrode pairs.

30. An article according to claim 23 comprising a quantum dot device including a substrate supporting a plurality of nanoscale islands of semiconductor material, wherein the electrolytically deposited nanoscale features comprise the semiconductor nanoscale islands.